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(54) Image processing apparatus.

(57) Image processing apparatus with a colour saturation controller for processing a colour image signal to be printed derives colour difference signals (61) from an incoming colour image signal, detects (62) a minimum difference value between an allowable dynamic range of colour difference signals and the derived colour difference signals, and generates (63) a coefficient value based on the detected minimum difference value. The levels of the derived colour difference signals are corrected by multiplying (66) the generated coefficient value and the colour difference signals. The dynamic range of the input colour difference signals is extended by such multiplication within a range not causing any overflow, and the colour saturation is directly corrected without changing the colour phase of the image signal.

FIG. 5

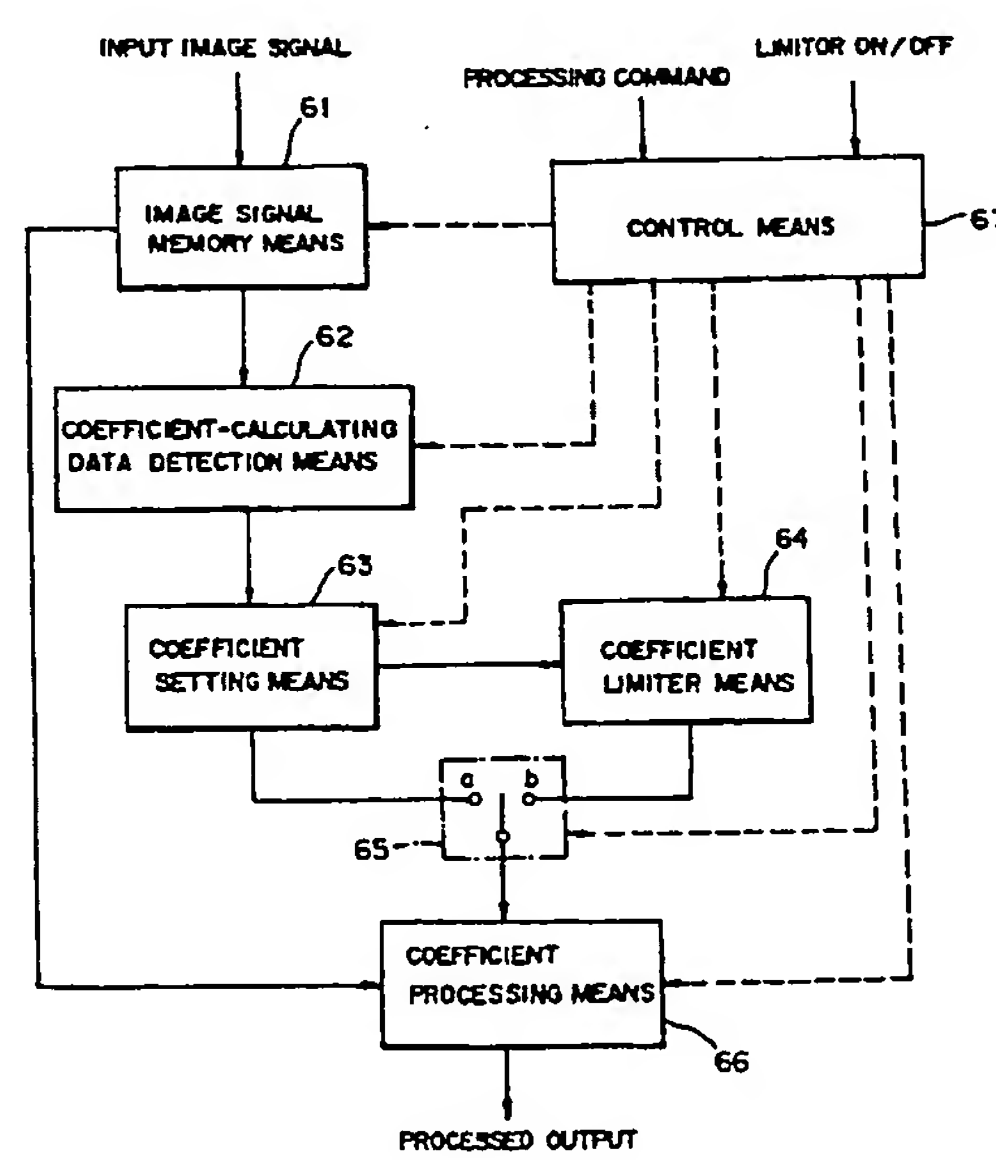


IMAGE PROCESSING APPARATUS

This invention relates to image processing apparatus that processes an input image signal to generate a print signal.

Technical development of still print image processing is currently in progress, wherein a video signal (still image signal) of one frame obtained from a video source such as a television camera, video disc electronic still camera or the like is supplied to an image processor, which then processes the input image signal to generate a desired print signal. The print signal is supplied to a printing device to control the printing of the image.

Figure 9 is a block diagram of an example of an image processing system, comprising an image signal output unit 1 for generating a video signal (still image) of one frame. The image signal output unit 1 may comprise or respond to a television camera or the like. The still image signal derived therefrom is fed to an image processor 2, and is processed in compliance with the signals generated by a processing control console 2A. The image processing executed with respect to the supplied original still image signal includes noise reduction, luminance control, colour saturation control, image conversion (enlargement, reduction, rotation, image size change) and so forth. Such image processing is known per se and thus is not described in detail herein. The processing control console 2A comprises input means such as a keyboard and a mouse and display means including a processing operation monitor, an image monitor and so forth.

A printer 3 is supplied with the output signal of the image processor 2 suitably converted to print signals of, for example, four colours C, M, Y and K (cyan, magenta, yellow and black) after completion of the image processing, whereby the operation of printing the colour image is executed by the printer 3.

In this image processing system, there exists the problem that when the image signal obtained from a video camera or the like is fed into the image processor 2 via the image signal output unit 1 and then the image is processed by the image processor 2 while being displayed on a monitor television receiver or the like, the colour saturation of the printed image is reduced as compared with the colour saturation of the image displayed on the monitor television receiver.

If proper colour saturation is not obtained, the colour saturation can be improved by individually controlling the three primary colour signals R, G, B (red, green, blue) or C, M, Y (cyan, magenta, yellow) in the printer 3. In such a case, however, the colour phase is changed simultaneously, so that there is considerable difficulty, when employing individual colour adjustment, in controlling the colour saturation without disturbing the colour phase.

According to the present invention there is provided image processing apparatus having a colour saturation controller for processing a colour image signal to be printed, said apparatus comprising:

input means for providing an incoming colour image signal;

colour difference means responsive to said input means for deriving colour difference signals from said incoming colour image signal;

detecting means responsive to said colour difference means for detecting a minimum difference value between an allowable dynamic range of colour difference signals and said derived colour difference signals;

coefficient setting means responsive to said detecting means for generating a coefficient value based on said detected minimum difference value; and

multiplying means response to said coefficient setting means for correcting the levels of said derived colour difference signals by multiplying said generated coefficient value and said colour difference signals.

Thus in an embodiment of image processing apparatus constructed in accordance with the invention, colour difference digital data are detected from a still image signal of one frame. The still image signal is composed of a luminance signal and two colour difference signals, and a coefficient is set to a proper value which is selected so as not to cause any overflow of the colour difference data beyond an allowable dynamic range (00000000 to 11111111 in an 8-bit arrangement) when the coefficient is employed to multiply the colour difference data. The colour difference data relative to each pixel of one frame are multiplied by a real number corresponding to such coefficient value, whereby the dynamic range of the input colour difference signals is extended.

As the colour difference signals R-Y and B-Y are multiplied by a real number corresponding to the set coefficient value, the colour saturation can be easily, automatically and directly corrected without changing the colour phase of the image signal.

Preferably, the image processing apparatus further comprises means for limiting the coefficient value obtained from the coefficient value generating means.

Setting the coefficient to a value that does not cause any overflow can be accomplished by the provision of a coefficient-calculating data detection

means for detecting a minimum difference value (difference data) between the colour difference data in each pixel and the upper limit value (for example, 11111111) or the lower limit value (for example, 00000000) of the dynamic range; and a coefficient setting means for calculating, on the basis of the detected minimum difference value, a proper coefficient value which is capable of reducing the minimum value (difference data) to zero by multiplying the colour difference data.

Where the image signal comprises a luminance signal Y and two colour difference signals R-Y and B-Y, the colour phase or hue is represented, as graphically shown in Figure 1, by an angle θ which is formed by the B-Y axis and a vector C of the relevant colour in plane coordinates with R-Y and B-Y plotted as mutually orthogonal axes. Meanwhile the colour saturation is represented by $|C|$, which corresponds to the magnitude of the vector C. Therefore, control of the colour saturation alone can be achieved by multiplying $|C|$ and a real number, as indicated in Figure 1 by a dotted line.

Consequently, the colour saturation of the image signal can be improved by multiplying the colour difference signals R-Y and B-Y and the real number (coefficient value) in the processing means.

Furthermore, because of the use of the value obtained in the coefficient setting means, it becomes possible to avoid a partial loss of the signal due to an excess of the multiplied result beyond the allowable dynamic range.

The invention will now be described by way of example with reference to the accompanying drawings, throughout which like parts are referred to by like references, and in which:

Figure 1 is a graph representing colour phase data and colour saturation data;

Figure 2 is a block diagram of an image processing system equipped with an embodiment of image processing apparatus according to the present invention;

Figure 3 is a block diagram of the image processing apparatus;

Figure 4 is a flowchart showing operations performed in the image processing apparatus;

Figure 5 is a function block diagram of a preferred embodiment of the present invention;

Figure 6 is a graph representing the operation of detecting colour difference signals;

Figure 7 is a flowchart showing the operations performed in a preferred embodiment;

Figures 8(a) and 8(b) are graphs representing the operation of a coefficient limiter; and

Figure 9 is an exemplary diagram of an image processing system.

The exemplary system of Figure 2 is constructed so that an image signal transmitted in a suitable way can be processed and printed, for example, as a photograph in a newspaper. First a description will be given with regard to such image processing system.

Figure 2 shows an imaging device 10 such as a television camera; a video reproducer 11 (TV monitor) for reproducing the video image picked up by the imaging device 10; and a still picture transmitter 12 capable of transmitting, via a telephone line, a communications satellite link or the like, a desired picture (colour video signal of one frame) out of the entire picked-up video image.

A still picture receiver 20 receives the picture derived from the still picture transmitter 12, and a receiving monitor 21 displays the received picture. The still image signal received by the picture receiver 20 comprises a luminance signal (Y signal) and two colour difference signals (R-Y and B-Y signals) of one frame, and is supplied sequentially to an image processor 30. A still image signal source such as a video disc unit, videotape recorder, television receiver or the like is provided as an alternative source of a still image signal input to the image processor 30.

As will be described in detail later, the image processor 30 is such as to perform various operations on the image signal supplied thereto, such as storing the image signal, processing the image, and generating a suitable print signal.

A console 40 comprises a control display 41, a keyboard 42, a mouse 43 and a processed image monitor 44. This console 40 is manipulated by an operator to execute various operations of the image processor 30.

A printer 50 is supplied with the print image data that are processed by the image processor 30 and converted to print colour signals of, for example, C, M, Y and K (cyan, magenta, yellow and black) and then prints the desired image.

By virtue of the system described above, an image obtained by picking up, for example, a news scene and phototelegraphed by the still picture transmitter 12 is immediately processed so that is then supplied directly to the printer 50. Thus, the apparatus is effectively utilizable under on-line control for an editing system or the like employed, for example, by a newspaper publishing company.

In the image processing system shown in Figure 2, the image processor 30 embodying the present invention is constructed as illustrated in Figure 3 and serves as a host computer to the entire system. That is, the image processor 30 comprises a program ROM 31 wherein various control programs are stored; an input image memory (hard disc) 32 wherein image data supplied from an image source such as the still picture receiver 20 is sequentially stored; a central processing unit (CPU) 33 serving as a controller; an

output image memory 34 for storing an output image signal converted to individual colour signals C, M, Y and K (cyan, magenta, yellow and black) after being processed for printing; and an input-output interface 35 for transferring the image data to or from the console 40. The CPU 33 comprises a system controller 33A for controlling the operations of the component elements in accordance with an operation program, a processing unit 33B for executing various processings, and a work memory (main storage memory) 33C.

The still image signal supplied to the image processor 30 is sequentially stored in the hard disc 32. Then the image data are read out from the hard disc 32 in accordance with requirements, and the image processing routines as shown in a flowchart of Figure 4 are executed principally by operations in the CPU 33.

In the image processing procedure, first the image data to be processed are loaded from the hard disc 32 into the CPU 33 [F100], and then the processing control picture representing the contents to be processed is displayed in the form, for example, of a menu on the control display 41 of the console 40 [F101].

The processing function is determined [F102] in response to an input from the operator via the keyboard 42 or the mouse 43, and then the determined processing routine is executed. More specifically, there is executed one function selected from the functions of image conversion, noise reduction, colour saturation control, sharpness control and so forth. These functions are denoted by F103a, F103b, F103c, F103d ..., respectively. As for the image conversion in F103a, any of enlargement/reduction, centre position change, rotation, image size change and so forth can be executed with respect to the original image supplied as an input. Although the functions F103a, F103b, F103c, F103d ... are shown in parallel in the flowchart of Figure 4, such functions may of course be executed sequentially in any order.

The image signal processed in F103 is supplied to the processed image monitor 44 (Figure 2) and displayed [F104] so that the operator can check the current stage in the processing procedure. When another function is to be executed, the operator manipulates the keyboard 42 to the mouse 43 of the console 40 to select the processing routine appropriate to the new function [F105 → F102].

After completing all of the image processing operations, the image signal is converted to C, M, Y and K colour signals to be printed [F106], and then such signals are stored as output data in the output image memory 34 [F107]. Subsequently, the data thus stored are supplied to the printer 50 (Figure 2) from the output image memory 34 (Figure 3) either automatically or by manipulation of the console 40, whereby one full colour image is printed with the image signals of four colours C, M, Y and K.

Such image processing apparatus can control the colour saturation [F103c] automatically in a highly effective way.

Figure 5 is a function block diagram of means for realizing the colour saturation control in the preferred embodiment of the invention. Such function blocks are preferably constituted by software in the CPU 33.

Image signal memory means 61 holds Y, R-Y and B-Y digital image signals (in this embodiment, 8-bit signals) of one frame read out from the hard disc 32 for processing. Coefficient-calculating data detection means 62 detects from the R-Y signal data and the B-Y signal data stored in the image signal memory means 61, a maximum colour difference data value or a minimum colour difference data value (within one frame of the image) which is the closest to the upper limit value 11111111 or the lower limit value 00000000 of the dynamic range, and then supplies coefficient calculating data based on the difference between the detected value and the upper or lower limit value.

More specifically, in the coefficient-calculating data detection means 62, the operation is performed in such a manner that, with respect to the colour difference signal represented graphically by a solid line in Figure 6, any data greater than the centre value C are compared with the upper limit value D_{max} to obtain the difference therebetween, while any data smaller than the centre value C are compared with the lower limit value D_{min} to obtain the difference therebetween , and the minimum difference data d_{min} are used as the coefficient calculating data.

Coefficient setting means 63 sets a proper coefficient value on the basis of the coefficient calculating data d_{min} supplied thereto. As will be described later, the coefficient value is set so that the results of multiplying it by the R-Y and B-Y data never exceed, in absolute value measured from the centre value C, the upper limit value D_{max} or the lower limit value D_{min}.

Coefficient limiter means 64 provides as an output a predetermined coefficient value when the set coefficient value is in excess of a certain limit value. Coefficient processing means 66 extends the dynamic range of the colour difference data by multiplying the set coefficient value and the R-Y and B-Y data. Under the control of the control means 67, switching means 65 connects either the coefficient setting means 63 or the coefficient limiter means 64 to the coefficient processing means 66. The multiplication of the coefficient value is executed for extension towards the upper limit val-

ue D_{max} with respect to any data greater than the centre value C, or towards the lower limit value D_{min} with respect to any data smaller than the centre value C.

The operations of such means are controlled individually in response to operation control commands and address data supplied from control means 67 (through control signal paths indicated by dotted lines). At the time of colour saturation control, the control means 67 receives a control execution command from the console 40 and also on/off data therefrom for the coefficient limiter means 64.

By virtue of the function blocks incorporated in the CPU 33 and described above, automatic colour saturation control can be performed with regard to the loaded image data by the control means 67 in accordance with the procedure shown in the flowchart of Figure 7.

When the colour saturation control is started [F200] after the image data have been loaded and stored in the image signal memory means 61, the coefficient-calculating data detection means 62 first detects the R-Y data to determine the minimum difference data d_{min} R-Y as described previously [F201] and then detects the B-Y data to determine the difference data d_{min} B-Y [F202]. The smaller one of these values is detected [F203] and supplied as coefficient calculating data X to the coefficient setting means 63 [F204, F205].

The coefficient setting means 63 sets a coefficient value K which is capable of extending the dynamic range of the R-Y and B-Y signals without, however, causing any overflow [F206]. More specifically, there is determined a proper coefficient value K for adjusting the maximum value or minimum value in the colour difference data to D_{max} or D_{min}. Such coefficient value K can be obtained from the following calculation:

$$K = \frac{\text{Dynamic range} / 2}{(\text{Dynamic range} / 2) - X}$$

When the coefficient limiter means 64 is in its off-state, the coefficient value K thus obtained is supplied directly via a contact a of the switching means 65 to the coefficient processing means 66, thereby to multiply the colour difference data in each pixel [F207 → F208 → F209]. As a result of such multiplication, the colour difference signal represented by a solid line in Figure 6 is converted to a signal whose dynamic range is extended as indicated by a dotted line in Figure 6. In this case, the colour difference data multiplied by the coefficient value K never exceed the value D_{max} and D_{min} as described previously, thus avoiding the partial loss of the colour saturation information that would result in case of overflow.

Depending on the image content, it is not necessarily preferred to increase the colour saturation by maximally extending the dynamic range. In this embodiment, therefore, the aforementioned coefficient limiter means 64 is additionally provided to limit the coefficient value. More specifically, when the coefficient limiter means 64 is in its on-state, a decision is made in F210 as to whether the set coefficient value K is in excess of a predetermined limit value k_L. If the set coefficient value K is beyond K_L or $-K_L$ as graphically shown in Figure 8-(a), the predetermined coefficient value is supplied to the coefficient processing means 66 [F211]. Such limitation may be effected gradually as shown in Figure 8(b).

Upon completion of the colour saturation control based on extension of the dynamic range of the colour difference signals as described above, the procedure advances to F104 in the flowchart of Figure 4, and after termination of the desired process, the signal is converted into an image signal ready to be printed as mentioned before. Subsequently a printed image is obtained from the printer 50.

The image processing apparatus of this embodiment is constructed so that the dynamic range of the colour difference signals is automatically extended within an allowable range, whereby it is unnecessary for an operator to supply as inputs any numerical value or the like, and there is obtainable a complete printed image wherein satisfactory colour saturation is maintained. Furthermore, because of the limitation of the coefficient value by the coefficient limiter means, there never occurs an undesired state where the colour saturation is increased to such an extent that saturation information is lost.

It is to be understood that the coefficient setting operation is not restricted to the example shown in the flowchart of Figure 7 and the calculation method mentioned above; any other method may be employed provided that it obtains a coefficient suited to convert the colour difference signals within the allowable dynamic range.

With the image processing apparatus of the present invention, as described above, it is possible to control the colour saturation data by automatically extending the dynamic range of the colour difference signals without changing the colour phase. This makes it easy to obtain a print image of proper hue and colour saturation.

Claims

1. Image processing apparatus having a colour

saturation controller for processing a colour image signal to be printed, said apparatus comprising:
input means (32) for providing an incoming colour image signal; colour difference means (61) responsive to said input means (32) for deriving colour difference signals from said incoming colour image signal;
detecting means (62) responsive to said colour difference means (61) for detecting a minimum difference value between an allowable dynamic range of colour difference signals and said derived colour difference signals;
coefficient setting means (63) responsive to said detecting means (62) for generating a coefficient value based on said detected minimum difference value; and
multiplying means (66) response to said coefficient setting means (63) for correcting the levels of said derived colour difference signals by multiplying said generated coefficient value and said colour difference signals.

2. Apparatus according to claim 1 further comprising coefficient limiter means (64) responsive to said coefficient setting means (63) for placing a limit on said coefficient value obtained from said coefficient setting means (63), said limit being such that the colour saturation is not maximally extended within said allowable dynamic range.

3. Apparatus according to claim 2 further comprising switch means (65) for selectively making said coefficient limiter means (64) effective or ineffective to place said limit on said coefficient value.

4. Apparatus according to claim 1 wherein said colour difference signals in said incoming colour image signal comprise a signal R-Y and a signal B-Y and said detecting means (62) detects said minimum value for both of said signals R-Y and B-Y.

5. Apparatus according to claim 1 wherein said allowable dynamic range is selected to be small enough for no saturation information to be lost.

6. Apparatus according to claim 1 further comprising printer means (50) responsive to said multiplier means (30) for printing a colour image.

FIG. 1

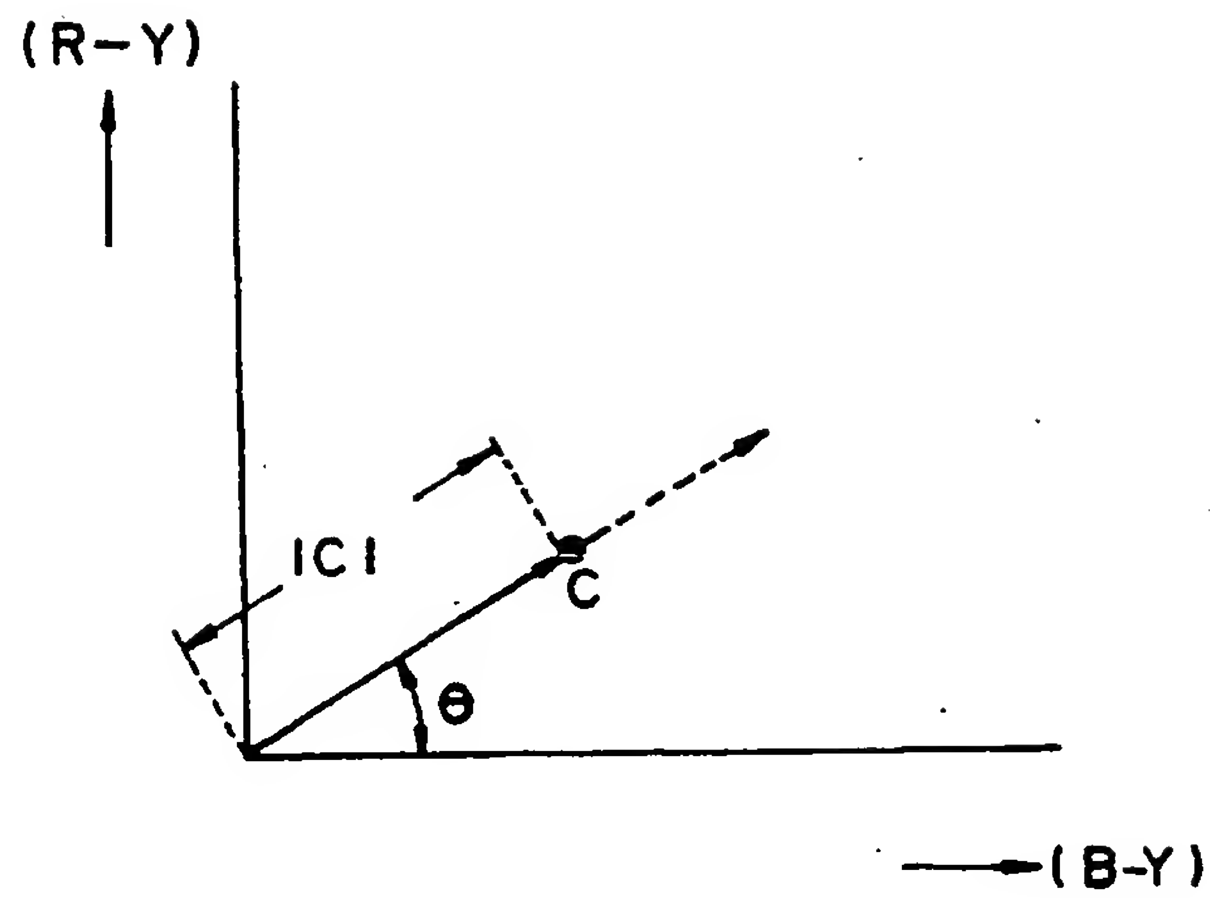


FIG. 6

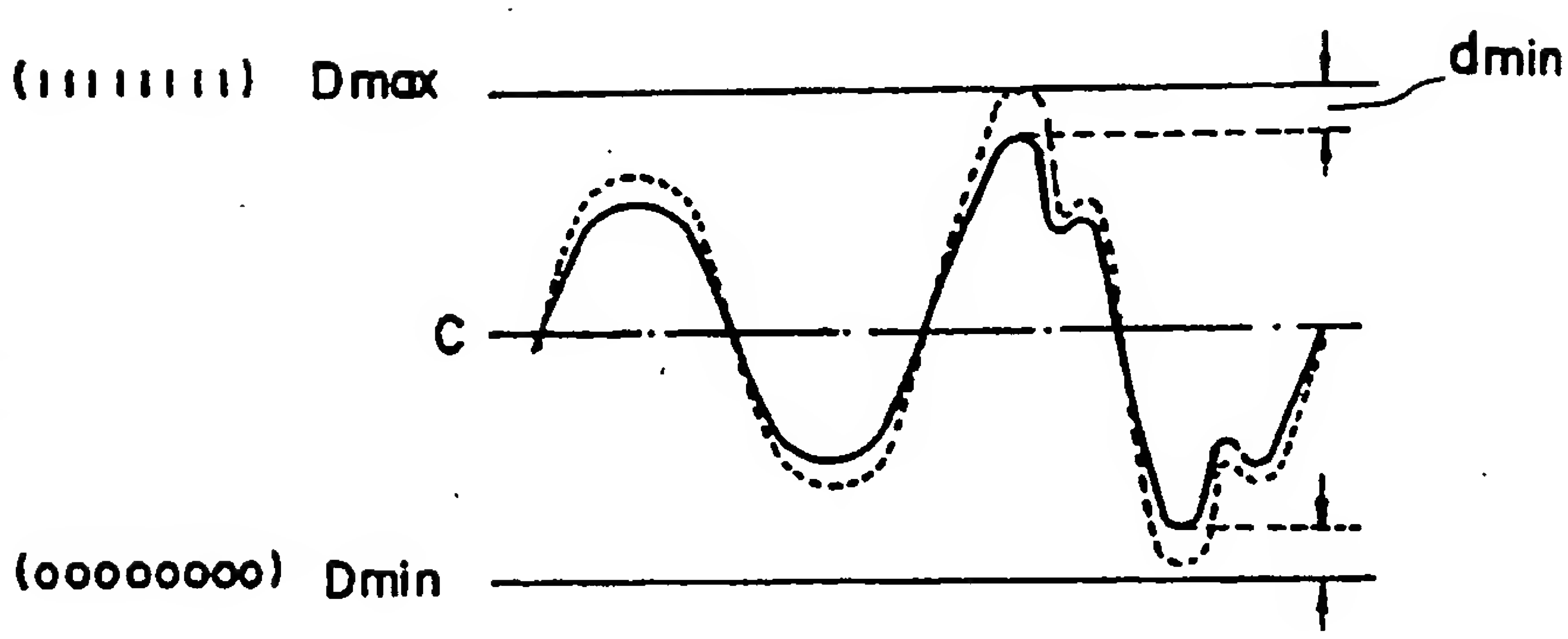
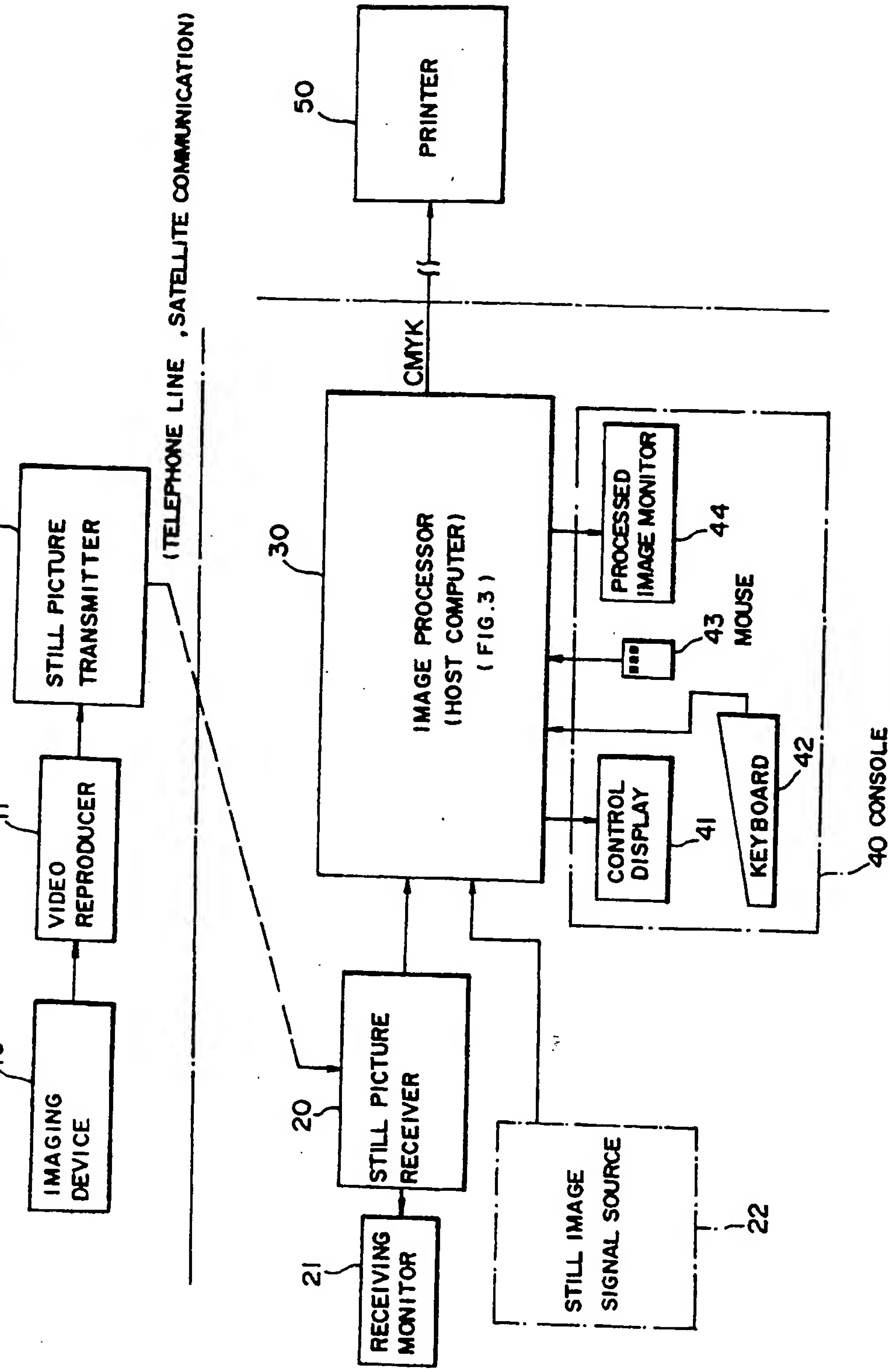


FIG. 2



10
IMAGING DEVICE
11
VIDEO REPRODUCER
12
STILL PICTURE TRANSMITTER
(TELEPHONE LINE , SATELLITE COMMUNICATION)
20
STILL PICTURE RECEIVER
21
RECEIVING MONITOR
22
STILL IMAGE SIGNAL SOURCE
30
IMAGE PROCESSOR (HOST COMPUTER) (FIG.3)
CMYK
50
PRINTER
40 CONSOLE
41
CONTROL DISPLAY
42
KEYBOARD
43
MOUSE
44
PROCESSED IMAGE MONITOR

FIG. 3

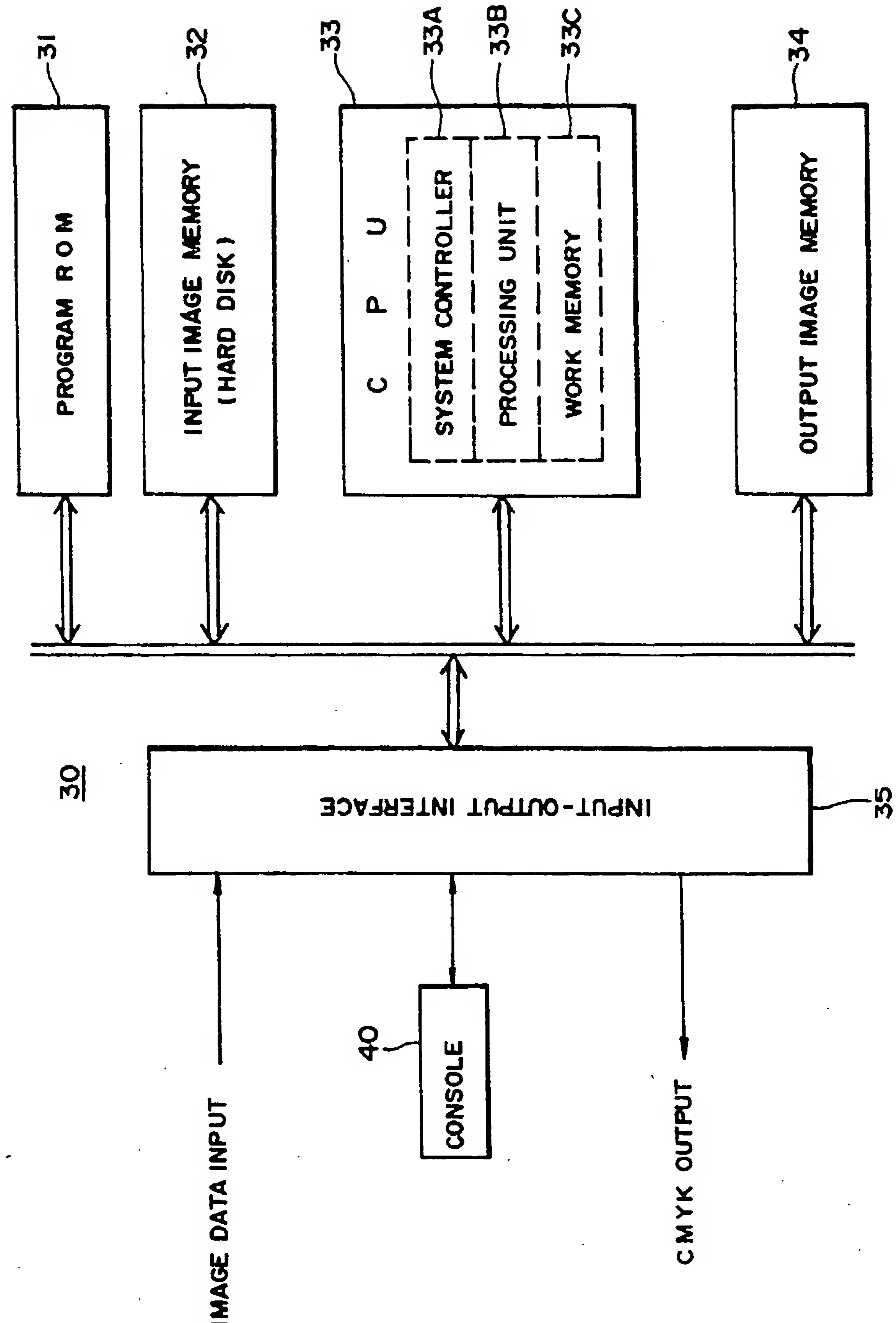

30
31
PROGRAM ROM
32
INPUT IMAGE MEMORY
(HARD DISK)
33
CPU
33A
SYSTEM CONTROLLER
33B
PROCESSING UNIT
33C
WORK MEMORY
34
OUTPUT IMAGE MEMORY
35
INPUT-OUTPUT INTERFACE
40
CONSOLE
IMAGE DATA INPUT
CMYK OUTPUT

FIG. 4

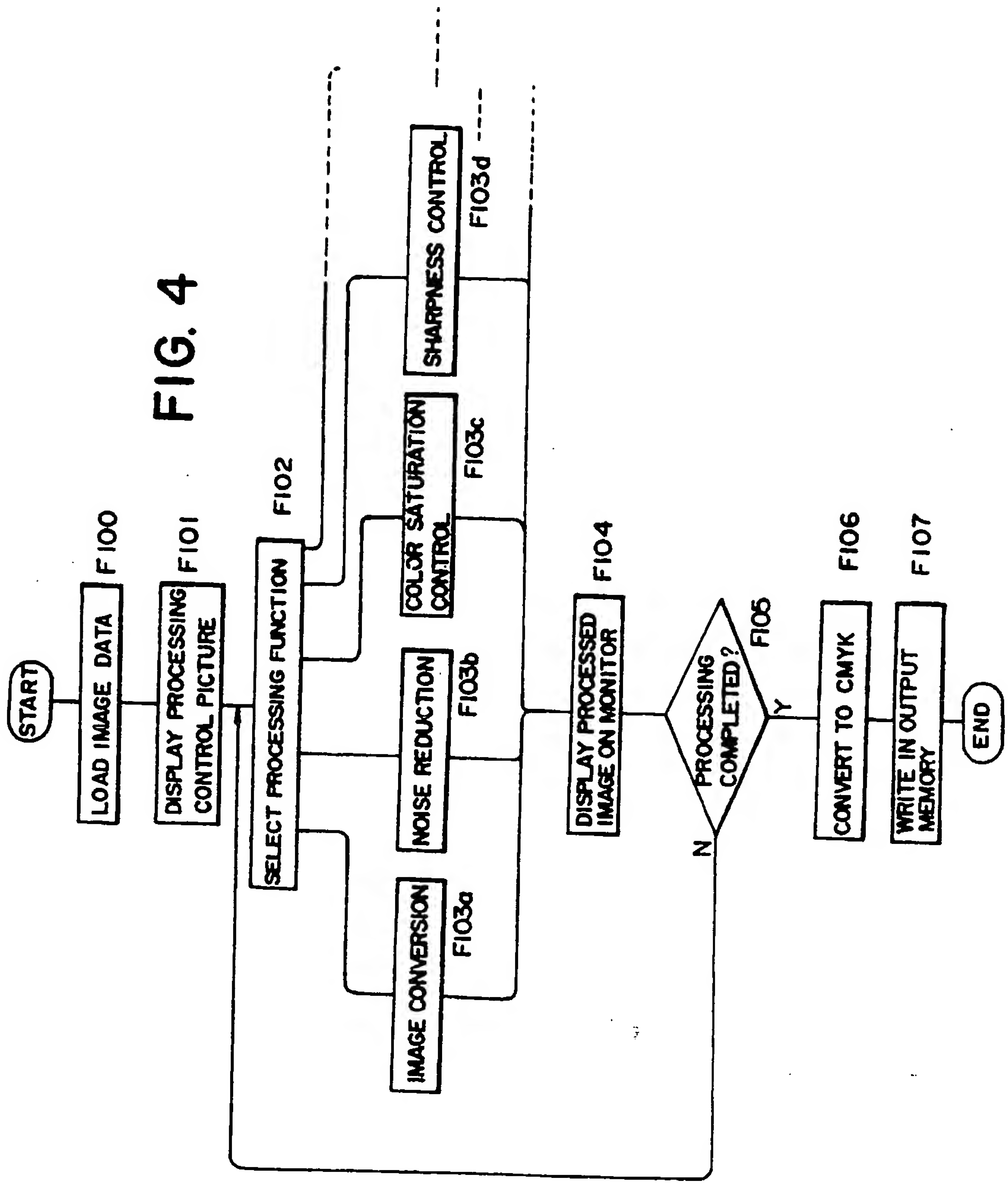

START
LOAD IMAGE DATA
F100
DISPLAY PROCESSING CONTROL PICTURE
F101
SELECT PROCESSING FUNCTION
F102
IMAGE CONVERSION
F103a
NOISE REDUCTION
F103b
COLOR SATURATION CONTROL
F103c
SHARPNESS CONTROL
F103d
DISPLAY PROCESSED IMAGE ON MONITOR
F104
PROCESSING COMPLETED?
F105
N
Y
CONVERT TO CMYK
F106
WRITE IN OUTPUT MEMORY
F107
END

FIG. 5

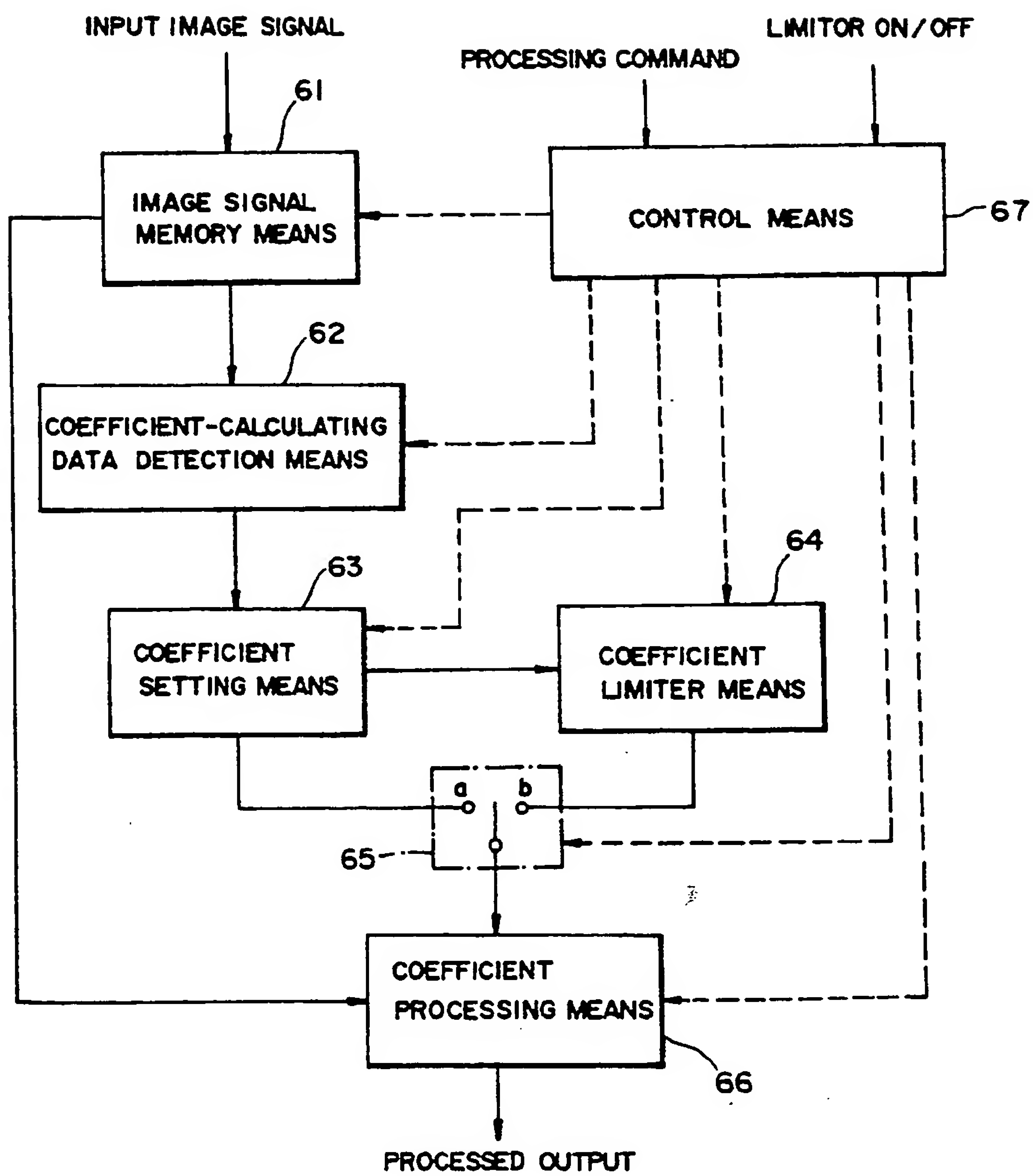

INPUT IMAGE SIGNAL
PROCESSING COMMAND
LIMITOR ON/OFF
61
IMAGE SIGNAL MEMORY MEANS
CONTROL MEANS
67
62
COEFFICIENT-CALCULATING DATA DETECTION MEANS
63
64
COEFFICIENT SETTING MEANS
COEFFICIENT LIMITER MEANS
a
b
65
COEFFICIENT PROCESSING MEANS
66
PROCESSED OUTPUT

FIG. 7

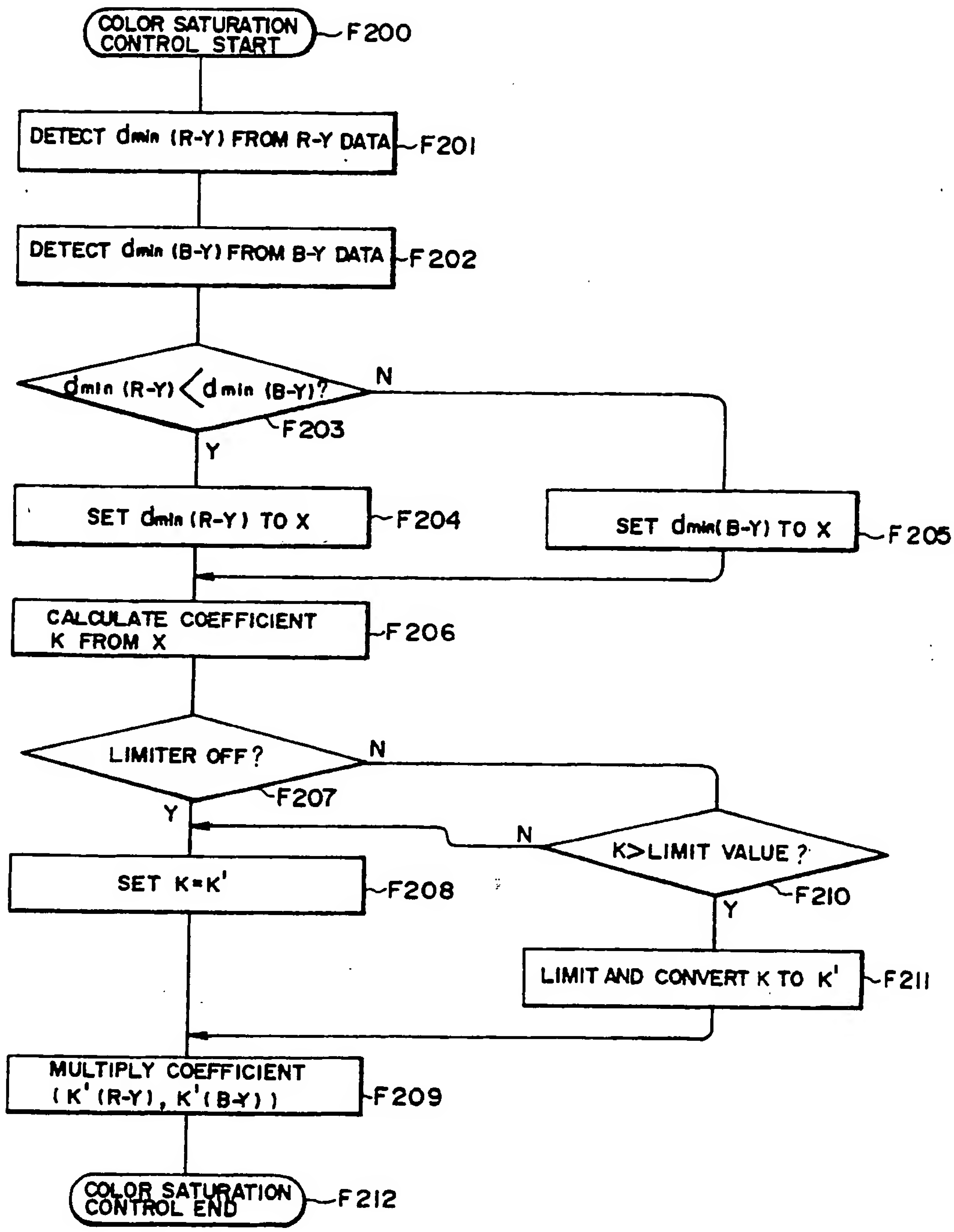

COLOR SATURATION CONTROL START
F200
DETECT dmin (R-Y) FROM R-Y DATA
F201
DETECT dmin (B-Y) FROM B-Y DATA
F202
dmin (R-Y) < dmin (B-Y) ?
F203
N
Y
SET dmin (R-Y) TO X
F204
SET dmin (B-Y) TO X
F205
CALCULATE COEFFICIENT K FROM X
F206
LIMITER OFF ?
F207
N
Y
K>LIMIT VALUE ?
F210
N
Y
SET K=K'
F208
LIMIT AND CONVERT K TO K'
F211
MULTIPLY COEFFICIENT (K' (R-Y), K' (B-Y))
F209
COLOR SATURATION CONTROL END
F212

FIG. 8(a)

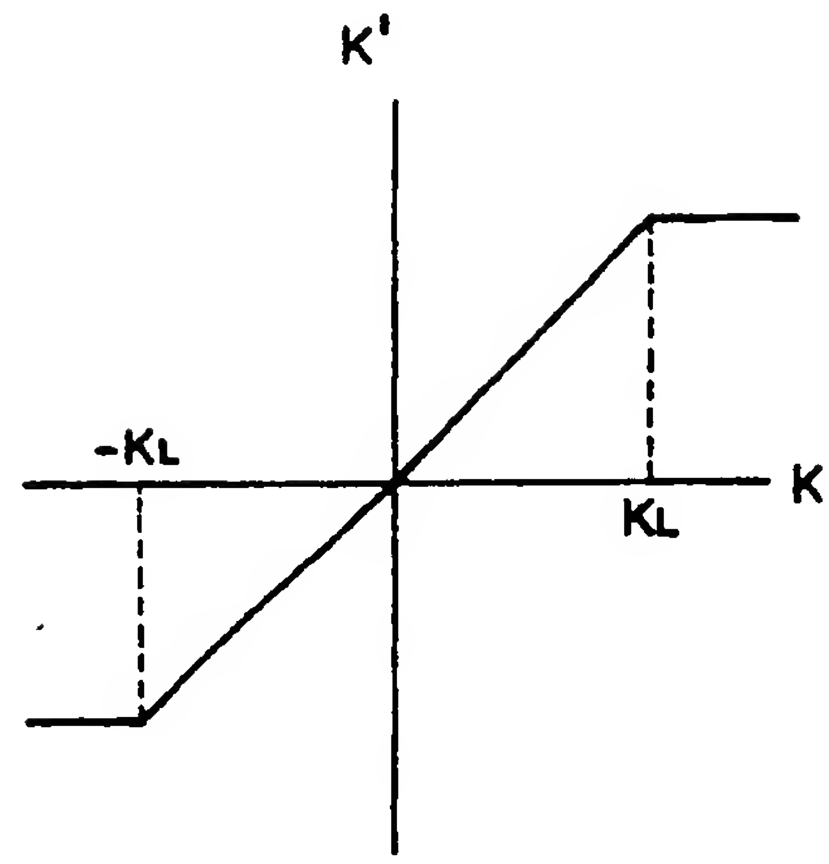


FIG. 8(b)

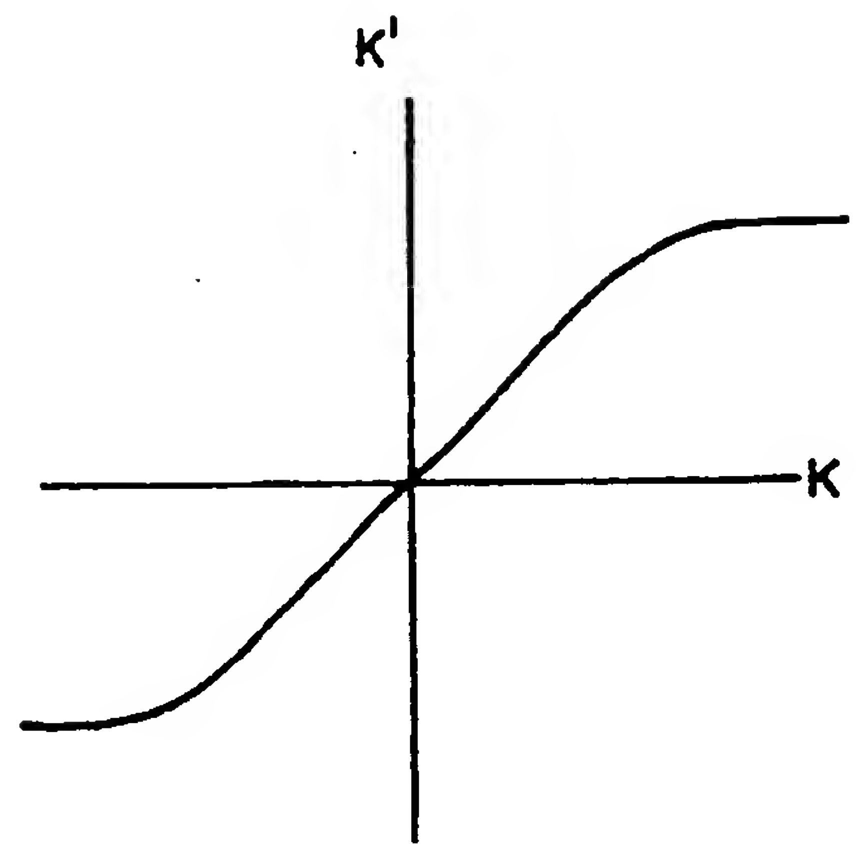


FIG. 9

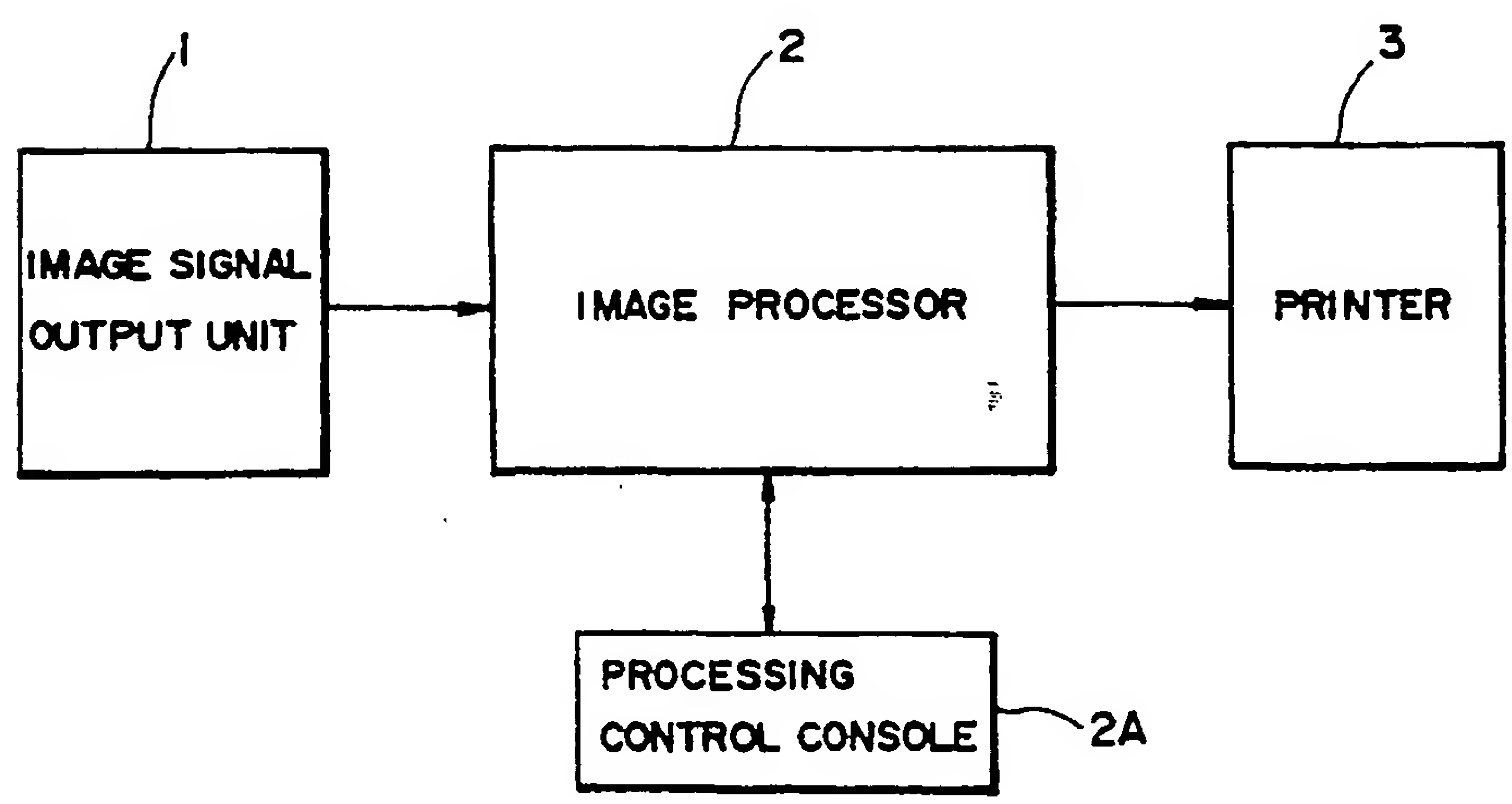


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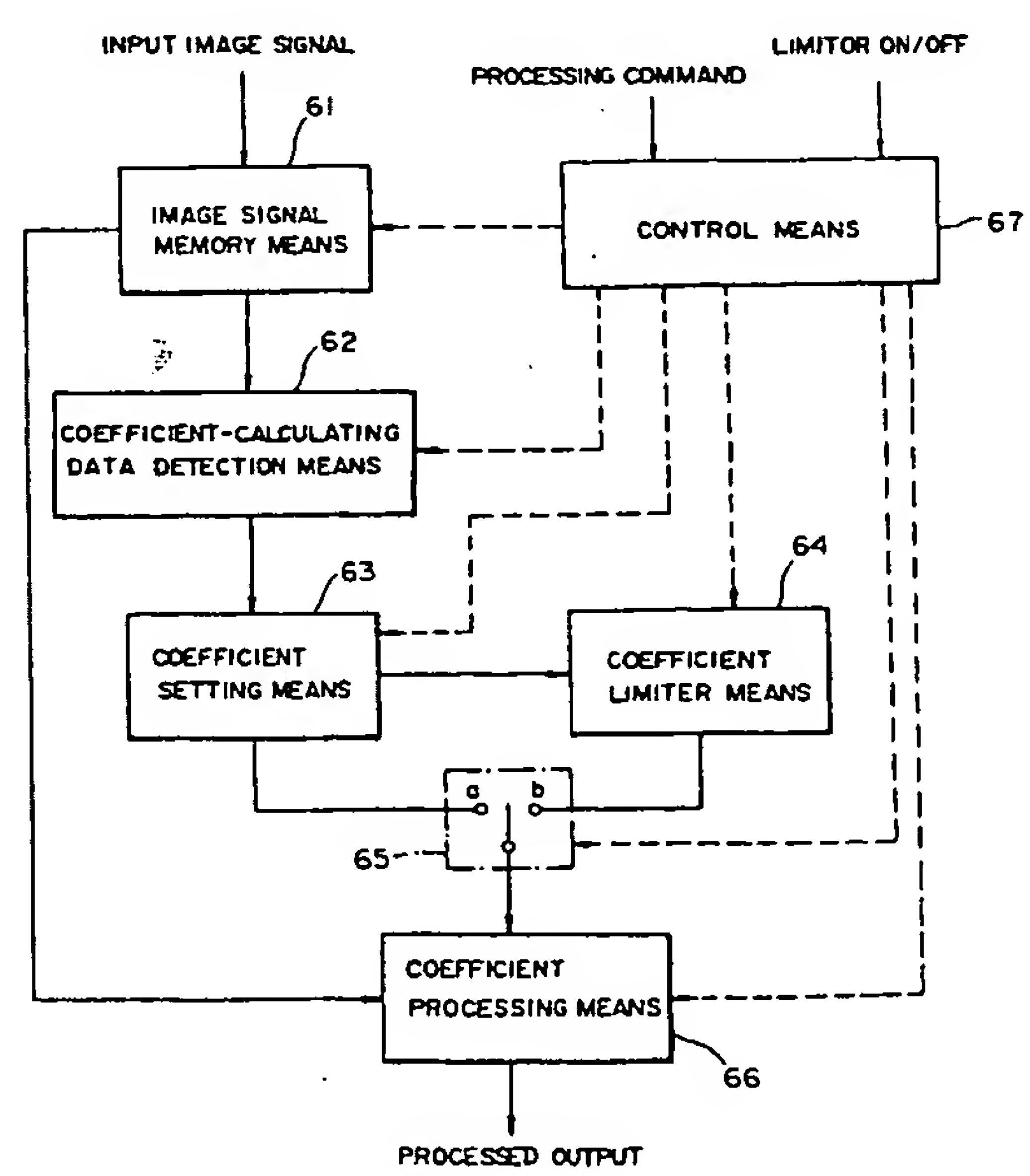
FIG. 5



EP 0 413 557 A3

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 90 30 8930

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
Y	DE-A-3 629 403 (AGFA-GEVAERT AG) * column 2, line 62 - column 3, line 37 * * column 5, line 67 - column 7, line 33; figures 3,4,5 * ---	1,4,6	H04N9/68 H04N9/64 H04N1/46
Y	FR-A-2 450 474 (DAINIPPON SCREEN SEIZO KABUSHIKI KAISHA) * page 11, line 39 - page 15, line 11; figure 6 * ---	1,4,6	
A,P	EP-A-0 340 033 (MINNESOTA MINING AND MANUFACTURING COMPANY) * page 3, line 41 - page 4, line 29 * * page 5, line 40 - page 6, line 45 * -----	1-6	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

H04N
G09G

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
BERLIN	11 MARCH 1992	MATERNE A.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document